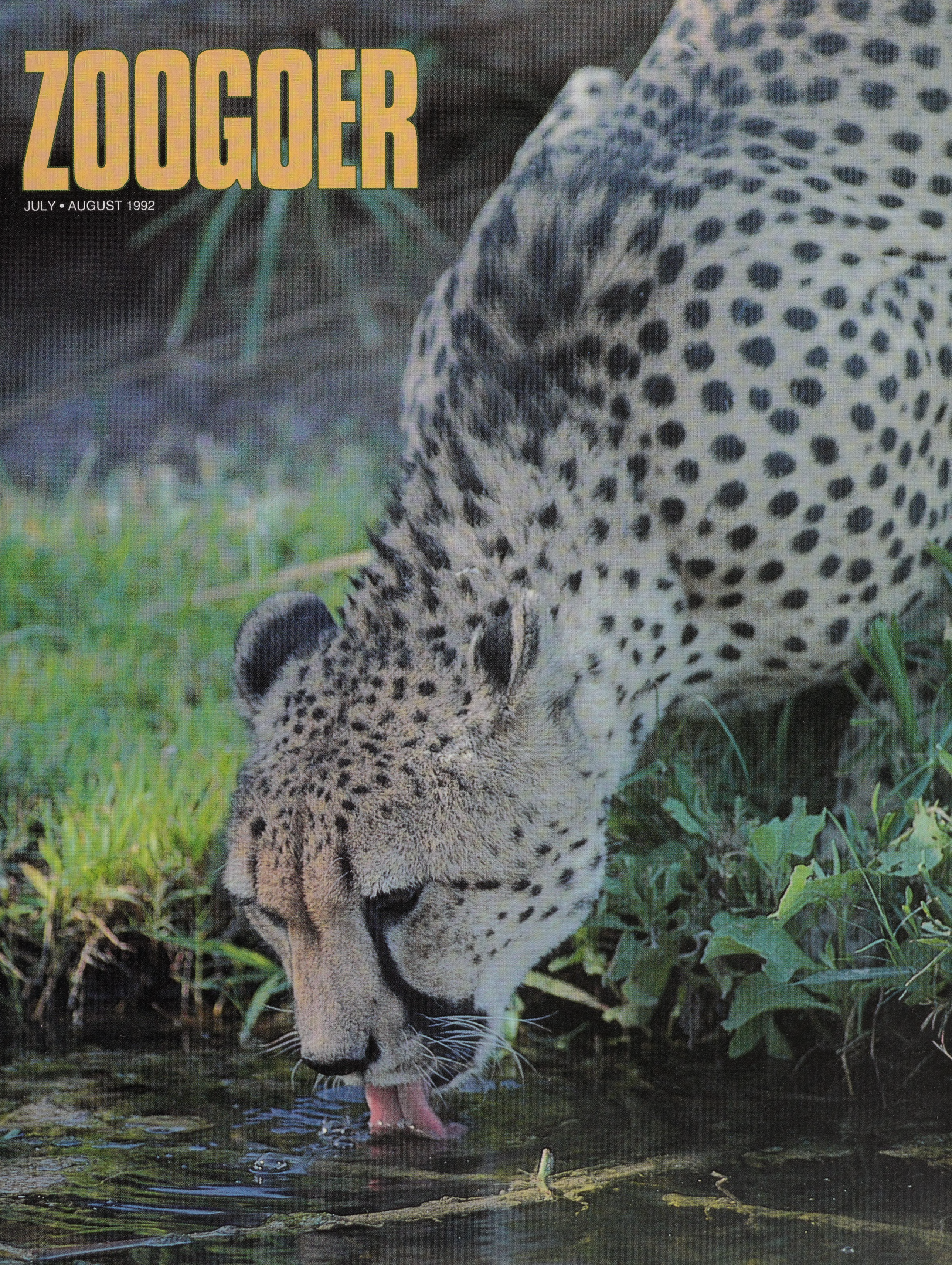
ZOOGOER

JULY • AUGUST 1992



Photograph by Michele Hallen, Watkins Glen, New York.

No print film gives you truer, more accurate color. Why trust your memories to anything less?

Show Your True Colors.™

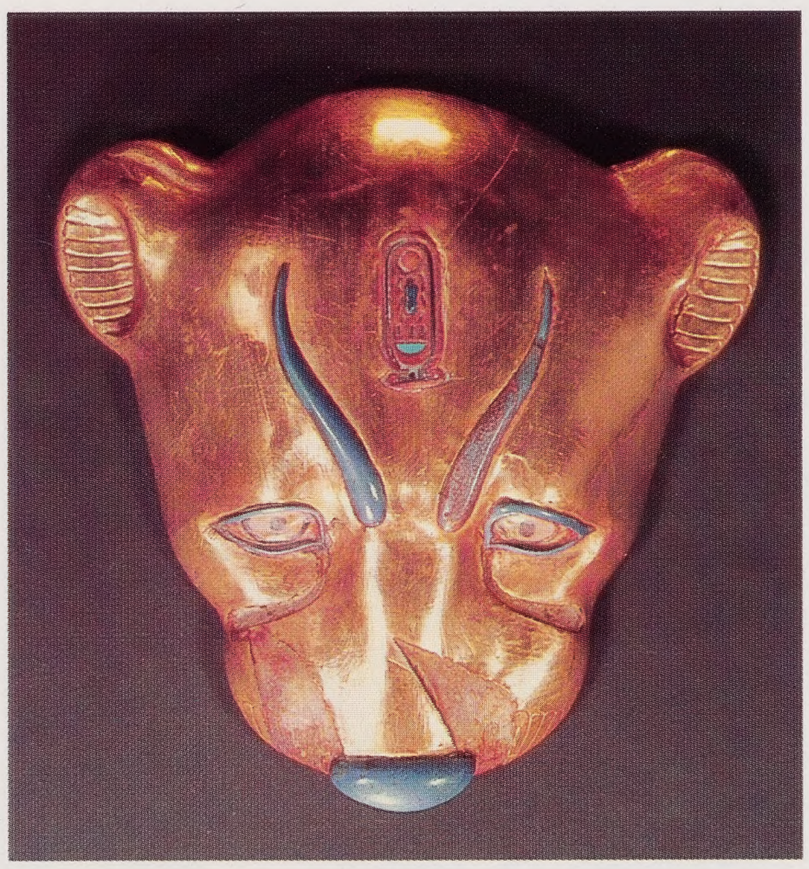
ZOOGOER

VOLUME 21 • NUMBER 4 • JULY • AUGUST 1992

CHEETAHS: SPECIAL SECTION

The opening of the Zoo's Cheetah Conservation Station, a groundbreaking exhibit and research facility, provides occasion for an in-depth look at these magnificent but highly endangered creatures.

FEATURE



Egyptian art. Head of Cheetah from Tomb of Tutankhamon. Cairo. Egyptian Museum. (Scala/Art Resource, N.Y.)

DEPARTMENTS

Friends of the National Zoo

is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

ZooGoer [ISSN 0163-416X] is published six times a year by Friends of the National Zoo to promote its aims and programs, and to provide information about FONZ activities to its members, volunteers, and others interested in the purposes of FONZ. The nonmember subscription rate is $12 a year. Third class mailing permit no. 6282.

The National Zoological Park is located in the 3000 block of Connecticut Avenue, N.W., Washington, D.C. 20008, 202-673-4717. Weather permitting, the Zoo is open every day except Christmas. Hours: From October 16 to April 14, grounds are open from 8:00 a.m. to 6:00 p.m.; buildings, 9:00 a.m. to 4:30 p.m. From April 15 to October 15, grounds are open from 8:00 a.m. to 8:00 p.m.; buildings, 8:00 a.m. to 6:00 p.m.
Director: Michael H. Robinson.

Membership in FONZ entitles you and your family to many benefits: publications, discount privileges, and invitations to special programs and activities to make your zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, D.C. 20008, or call 202-673-4960.

Membership categories are:

Family (includes children 3-16 years)	$44
Couple	$39
Individual	$34
Senior Citizen (individual or couple)	$24
Contributing	$75
Sustaining	$150
Patron	$250
Sponsor	$500
Benefactor	$1000
ZooGoer subscription only	$12

***ZooGoer* Staff:** Publisher: Clinton A. Fields
Editor: Susan Lumpkin
Associate Editor: Ward Merritt
Intern: Christopher Stuart

Contributing Editor: Robin Meadows
Consulting Editors, this issue: Robert Hoage, John Seidensticker
Copy Editor: Jean B. McConville
Design: Mosser Design, Inc.

Cover: Cheetahs drink water when it is available, but can survive without it by getting the water they need from their prey. *(Phoenix Zoo photo by Dick George)*

Mayor Kelly enjoys ZooFari. (Christy Bowe)

ZooFari 1992: Raves and Results

ZooFari once again received rave reviews all around—it was a great "Panda Mania" party. Fifteen hundred guests, 86 restaurateurs, 13 groups of entertainers, as well as underwriters American Express Card and the Coca-Cola Company, sponsors WKYS, WCXR, the Omni-Shoreham Hotel, Calvert Woodley Wine and Liquor, and artist Jane Gaston enjoyed an evening that Marty More of *The Express* newspapers called "one of the most successful and entertaining fundraisers in the region."

This year's Panda Mania raised more than $165,000—a new record—for the Zoo's Theodore H. Reed Animal Fund. More than ever before, ZooFari also helped heighten community awareness about FONZ, about the National Zoo, and, most important, about the need to conserve biological diversity and protect the environment.

But the real proof of a fundraiser's success remains its tangible results. Have ZooFari dollars—your dollars—helped make the National Zoo a better place for visitors and for wildlife conservation? The answer is a resounding yes. Here's how:

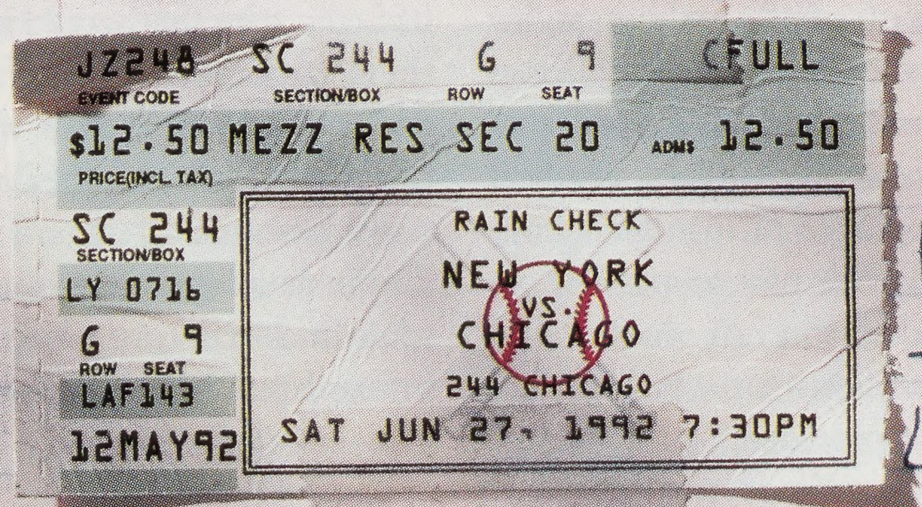
- The Cheetah Conservation Station, the opening of which is celebrated in this issue of *ZooGoer*, was partially funded by ZooFari proceeds.
- ZooFari funds brought a female Sumatran tiger to the Zoo to participate in a breeding program for this endangered tiger subspecies. This spring, the first Sumatran tiger cubs were born and can now be seen playing in their yard on Lion/Tiger Hill.
- ZooFari funds were used to acquire a mate for the Zoo's kiwi, a rare bird from New Zealand.
- The new American Indian Heritage Garden near the Small Mammal House was made possible by ZooFari funds.
- ZooFari funds are contributing to the development of Amazonia, which is scheduled to open in November. (ZooFari guests had a chance for a sneak preview of this fabulous new exhibit.)

And these are just a few of the projects that ZooFari funds have helped bring to fruition in the last few years. To all who contributed, thank you. Please accept my invitation to visit the Zoo often to see the results of your efforts.

Sincerely,

Clinton A. Fields
Executive Director

New York is really cool.
Today Dad and me got up before
Mom and went to Central Park,
We saw lots of joggers and
rollerskaters.
One guy did tons of tricks. Dad
said maybe I could get a pair. Then
We went back to the hotel and got
Mom and went to the Intrepid. WOW!
It's big! The guide said you could fit 3 1/2
football fields on the Intrepid. We also went
to see the new Barosaurus at the
American Museum of Natural History.
It was awesome! On the way we saw a
movie being filmed. I can't wait to tell
Steve. We ate hot
dogs & ices from a
stand. And then we went to the
World Trade Center. From the
top we could see the Statue of
Liberty and Ellis Island. That's
where my great Grandma and
Grandpa went through when they
came to America. Dad says what we're doing tonight's
a surprise. I hope it's a baseball game.
I see why Mom keeps saying



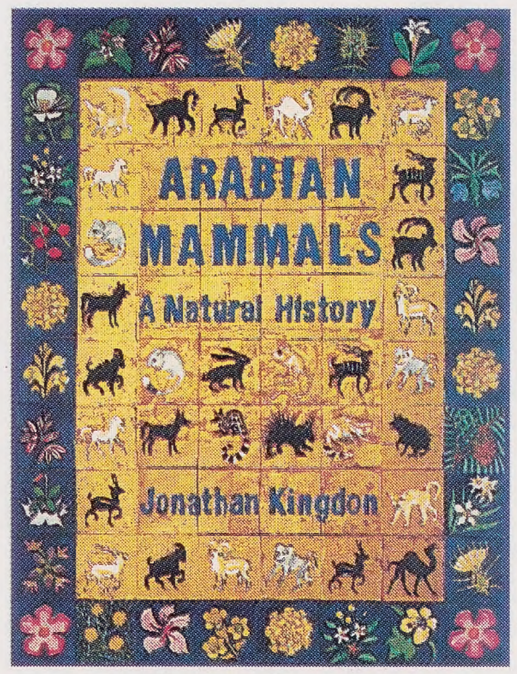
New York won 7-5

It's great to be back in the City!

PLEASE SEND ME A FREE I ♥ NY® CITY VACATION KIT

MAIL TO: I LOVE NEW YORK
P.O. BOX 514, ELMSFORD, NY 10523
OR CALL: 1-800-677-9200, EXT. 668

NAME _____
(PLEASE PRINT)
ADDRESS _____ APT _____
CITY _____ STATE _____ ZIP _____
003
PLEASE ALLOW 4 WEEKS FOR DELIVERY



African Silences.
1991. Peter Matthiessen.
Random House, New York.
225 pp. hardbound, $21.00.

Arabian Mammals: A Natural History.
1991. Jonathan Kingdon.
Academic Press, London.
279 pp. hardbound, $130.00.

One of the great problems ecologists face in measuring ecological change, especially large-scale changes in entire landscapes, is that they lack the most basic information on the history of these landscapes. When ecosystems are degraded and natural goods and services lost, people living in those ecosystems make mental adjustments. A father can tell his son how it once was, but the son will never really comprehend what he hasn't experienced himself. Geographer Clarence Glacken pointed out that this has been a fundamental pattern in the history of man as an agent of ecological change. As a result, we have few contemporary or historical accounts of ecological change in large regions of the globe.

When I think of Africa, it is East Africa—the Serengeti with its savannas and great herds of hoofed mammals and their predators—that I envision. I do not have a mental image of the many other landscapes of Africa, or of those across the Red Sea in the Arabian Peninsula. (Actually, I never thought much about Arabia at all until our collective national attention was so forcefully directed there by the Gulf War.) Peter Matthiessen's *African Silences* and Jonathan Kingdon's *Arabian Mammals* are books of great value because they introduce and describe vast and little-known African and Arabian landscapes. Both writers reflect on what was once there, and how it is all changed and changing. And both are writers with powerful descriptive skills and insights into the human forces that are at work to change these landscapes.

Kingdon takes us on a tour of Arabia. "Nothing on Arabia's scorched surface escapes the heat," he tells us about this harsh land, rich in culture and natural history. He reports that people visiting Arabia in the 1840s described herds of gazelles, oryx, ostriches, ibex, hyenas, wolves, and many more species. Then the English, French, and Germans began to export millions of cheap, mass-produced guns. By the beginning of this century, guns were ubiquitous among adult males in Arabia, and wild asses, lions, cheetahs, oryx, and ostriches had become very rare. Their extermination was only a matter of time. As Kingdon says, "There is no longer any part of Arabia where we can hope to see the working of nature on a large scale. Today we can only listen to the echo of the lion's roar in the yowling of a caracal or imagine a lioness throttling a gazelle when a feral cat pounces on a mouse. Thus are the scale and proportions of Nature reduced, but we, once an occasional prey, can suppose that we feel safer."

As he did in his monumental *East African Mammals*, Kingdon blends his marvelous drawings and text to bring to life the 105 mammalian species found (or found until recently) in Arabia. In describing their adaptations and natural history, he settles them into the varied landscapes of the Arabian Peninsula. His essays on camels and horses, for instance, are wonderful. Kingdon also discusses conservation, which involves a radical reappraisal of man's relationship with nature and the introduction of laws and institutions for which no explicit precedents exist in Arabia. But Kingdon tells us that there is much in Islamic scripture that is sympathetic to an ecological view of nature and that conservation issues are currently being addressed by Muslim ecologists, theologians, and legal experts.

In *African Silences*, Peter Matthiessen has drawn together accounts of his 1978 wildlife survey in Senegal, Gambia, and the Ivory Coast, his 1978 search for peacocks and gorillas in Zaire, and his 1986 travels in the Congo Basin in search of Pygmies and pygmy elephants with ecologist David Western. Reading Matthiessen's travelogue is like talking with an old friend through a late afternoon and into a tropical night while sitting in rattan chairs on a remote veranda overlooking an arrestingly beautiful African river. The rhythm and nuances of his language take you right there. You can feel it; hear it; smell it. Reading about landing a light airplane on a rough, scrubby field at nightfall, you hear the branches whacking the sides of the plane and picture the termite hills hidden in the stiff grass ready to rip the plane apart.

As Matthiessen describes flying on and on over unbroken Congo rainforest, after he and Western missed the Congo River from the air and thus missed a turn that would take them to Kinshasa's airfield and aviation fuel, you worriedly ask: How can they possibly get out of this one? Frequent accounts of tense, sometimes scary, negotiations to maneuver Matthiessen and his traveling companions around bureaucratic bullies leave you at once sympathetic and disheartened.

Matthiessen has a genius for telling observation. A car crash in Senegal that kills a steer leads him to note that "drivers in the new Africa go too fast, and life in the old Africa moves too slowly. A paved road has no place in medieval landscapes." In the Ivory Coast, the author attends a Senoufou N'Goron dance that "...took place in a garden square beneath a huge silk-cotton tree, around a

continued on page 8

Heritage Garden

A Heritage Garden exhibit featuring edible and medicinal plants used by American Indians is now open at the Zoo. Throughout the next months—and years—the garden will give Zoo visitors an idea of the cultural interaction triggered 500 years ago by Columbus's arrival in the New World. As a result of that contact, American Indians introduced Europeans to new plants that could heal a sick body and nourish a continent.

The American Indian Heritage Garden features 29 species of plants used primarily by Eastern Woodland Indians. It began to take shape last fall, when a group of 12 FONZ volunteers built an elevated boardwalk, 320 feet long, leading from Olmsted Walk to the back of the Small Mammal House.

The garden occupies a tranquil setting overlooking the valley of Rock Creek. Appropriately, just beyond the garden, visitors can glimpse American bison grazing in their enclosure, a reminder that a little more than two centuries ago, a subspecies of these massive bovines still roamed the rolling hills of the mid-Atlantic region.

Early this spring Zoo gardeners sowed seeds and now the plants are beginning to flourish. May apples, which served many Indian groups as a laxative, and bloodroot, a traditional treatment for rheumatism and open sores and now an ingredient in antiplaque mouthwash and toothpaste, nestle in the shade of a 40-foot sweet gum tree, an early source of relief for inflammation.

Farther along the boardwalk, arrowhead and black willow grow on the banks of a specially created miniature pond where cattails and wild rice, still a highly prized food, are growing. Corn, beans, sunflowers, squash, and black walnut trees also call the visitor's attention to the many valuable food resources the natives of North America contributed to the world's diet.

Cattails are among the dozens of useful plants growing in the new Heritage Garden. (Milton H. Tierney, Jr.)

Each of these familiar plants boasts a long history of use, and a visit to the Zoo's American Indian Heritage Garden is sure to encourage interest in the stories these plants have to tell, both about themselves and about the cultural groups who have discovered their special properties. But more important, the garden will help visitors comprehend that native peoples around the world enjoy an intricate relationship with their environments and have developed a sophisticated knowledge of the pharmaceutical value of plants. This knowledge is an invaluable information resource and a part of their legacy that can benefit everyone sharing this planet.

—Margie Gibson

Lecture and Film

The Zoo's film series winds up Saturday and Sunday, August 29 and 30, with *A Dog of Flanders*. Set in turn-of-the-century Belgium, the movie tells the story of a boy and his grandfather who adopt an ailing stray dog and struggle to nurse him back to health. Screenings are held in the Education Building Auditorium; showtime is 1:00 p.m., both days. For more information, call 202.673.4821.

As part of a two-day symposium on *Forest Remnants in the Tropical Landscape: Benefits and Policy Implications*, the Smithsonian Migratory Bird Center will sponsor a lecture in the Zoo's Education Building Auditorium by conservationist Paul Ehrlich. Ehrlich's lecture, *Miners' Canaries and Saving the Mine*, looks at the state of bird populations as an indication of environmental health. The lecture will be held Friday, September 11, at 8:00 p.m. Admission is free, but seating is limited and reservations are required. To reserve a seat, call 202.673.4801.

For information on autumn lectures at the National Zoo, please call 202.673.4801 *after* September 15.

Amazonia from Afar

A new photo exhibit in the Zoo's Education Building lobby, *Satellites and Rainforests: The Brazilian Space Agency and Preserving the Environment*, takes a look at Amazonia from hundreds of miles above the earth's surface. Through the lenses of the Landsat satellite, the Brazilian space agency (INPE is the Portuguese acronym) monitors images that reveal changes in the huge Amazon River basin.

The 14 photos in the exhibit each cover 20,500-square-mile sections of Amazonia. A gift from INPE to the National Zoo, the photos were gathered at South America's first Landsat receiving station in Cuiaba, Brazil. The exhibition serves as a prelude to the Zoo's Amazonia exhibit, scheduled to open in late fall, in which visitors will zoom in for a close-up view of these same vistas.

Tiger Stop Opens

A new alcove called "Tiger Stop" on Lion/Tiger Hill is

Collared peccaries are back at the Zoo after more than 10 years. (Milton H. Tierney, Jr.)

attracting children from all over the Zoo. For kids, Tiger Stop offers a colorful place to play and to see the Zoo's tigers. For parents, wide benches provide a place to sit and take a break, and watch the kids at the same time.

Within the alcove, thirsty toddlers find a huge tiger cutout overlooking the drinking fountain, and a colorful forest mural featuring several tigers. Large rocks invite climbing, and cushioned floors help prevent skinned knees. Best of all, plexiglass-enclosed platforms provide a bird's-eye view of the animals.

A place for romping and relaxation, Tiger Stop also helps teach children about animals. Simple graphics draw comparisons between tigers and children, showing kids how to observe the animals' behavior and then compare it to their own.

Zoo Director Michael Robinson praised the new Tiger Stop, whose opening coincided with the debut of the Zoo's Sumatran tiger cubs, saying "It is a tremendous day for me when I get to show off a creative new learning center and important new animals, especially my favorites, cats. These accomplishments demonstrate the exciting synergism of education, conservation, and science that only an institution like the National Zoo is able to create."

FONZ Board Members raised funds for Tiger Stop from the Clark-Winchcole Foundation, the Philip L. Graham Fund, the Arcana Foundation Inc., Howard Stein, the Max and Victoria Dreyfus Foundation Inc., the Hattie M. Strong Foundation, and the German Orphan Home Foundation. FONZ volunteer artists Barbara Sheehan and Jane Frieden painted the mural. Tiger Stop is the first in a series of stops that will eventually form the Zoo's Children's Trail.

—Christopher Stuart

Peccaries Return

In a corner of the new American Indian Heritage Garden, Zoo visitors will now find three collared peccaries (*Tayassu tajacu*), a species last seen at the Zoo more than 10 years ago. Related to pigs, collared peccaries resemble boars, but with long, slender legs, a coat of tough, thick hair, and a unique white collar running diagonally from the middle back to the chest. Like pigs, peccaries are omnivorous but prefer to feed on roots, seeds, and fruits.

In the wild, collared peccaries live in cohesive groups of 14 to 50 individuals. Mutual scent-marking and rubbing with glands located beneath the eyes is believed to aid in recognition between members of the group and often can be observed just before feeding. The Zoo's peccaries, one male and two females originally from the Detroit Zoo, seem to exhibit much of the same behavior.

Collared peccaries range from Argentina to as far north as Arizona and New Mexico. The collared peccary has actually extended its range in the southwestern United States, where it is classified as a game animal and subject to regulated sport hunting. An extensive hide and skin trade, combined with a loss of habitat due to forest clearance for farmland, has greatly reduced populations in Latin America. Considered pests because of their appetite for food crops such as yucca, corn, watermelons, and legumes, peccaries have also at times been the victims of local campaigns to exterminate the animals.

—Christopher Stuart

continued from page 6

bonfire that attracted quick, small bats.... Hair whisks shimmering in each hand...the children danced forward and back.... [T]he dance was a beautiful and stirring ceremony that summoned the deep mystery of the earth."

The book's title comes from Matthiessen's experiences in Senegal. "Even in the late afternoon the heat is terrific; the land shimmers in the hot breath of the *harmattan*. Senegal is the western borderland between the desert and the Guinea forest and this region between the desert and the savanna, called the Sahel, is an arid country of poor soils, hundreds of miles wide, that stretches all the way to the Sudan." In fact, this grassland belt flows across the face of Africa for 4,000 miles: a vast region once rich in large mammals and other wildlife, but, as Matthiessen finds, now vacant and silent.

These books are about man as an agent of ecological change, about nature disturbed and nature in transition. However, neither Matthiessen nor Kingdon attempt to answer the ancient question: What is the proper role for humans in nature?

—John Seidensticker
Curator of Mammals

Cheetahs

FRIENDS OF THE NATIONAL ZOO

Cheetahs

I have once seen a cheetah in action, in the scorching midday sun of Kenya's Masai Mara Reserve. The painfully thin but hugely pregnant female stalked a milling herd of nervous Thomson's gazelles with seemingly infinite patience. Then suddenly she took off in a vision-blurring burst of speed, scattering the gazelles and catching her quarry: a fawn, perhaps only a few days old. I was near enough to hear the fawn's desperate bleats, and see the female's exhaustion as she several times released her teethhold on the struggling animal's throat to catch her breath before the fawn finally suffocated.

To my, and, it seemed, the cheetah's surprise, a second fawn appeared just a few feet away. Still wobbly legged and utterly confused, the fawn had woken up to find the shelter of its herd gone. The female cheetah watched the fawn stumble in the grass and made tentative movements toward it. But she too seemed confused, or torn between impulses. Should she stay with her kill or, despite her exhaustion, go after this second fawn? When the fawn sank back into the grass, disappearing from view, the cheetah lost interest. We left the cheetah alone to start her meal.

Compared to the bloody scenes of lions ripping apart a zebra or wild dogs tearing chunks of flesh from the flanks of a still-struggling wildebeest, this act of predation was strangely serene. Twenty minutes after the cheetah separated the fawn from the herd, no blood had been spilled. The details of this one episode reveal a great deal about cheetahs, and about how perilously close to the edge they live.

Next page: *More diurnal in their activity patterns than most other cats, cheetahs rely on vision and vigilance to detect prey as well as predators, and prefer open habitats that offer unobstructed views of their surroundings.*

(Phoenix Zoo photo by Dick George)

Cover art by Jane W. Gaston.

Whence Cheetahs?

Eminent 19th-century biologist St. George Mivart said that the cheetah differs much more from all other cats than any two other cats differ from one another. The cheetah's paws appear more doglike than catlike: The pads are small and tough and the claws are blunt, only slightly curved, and lack the sheaths that cover the retracted claws of other cats. (The lack of sheaths is why people claim that the cheetah's claws do not retract at all—this is not true.)

Cheetahs also lack the powerful canine teeth possessed by all other cats. While most cats rely on a powerful, piercing, canine bite into the nape to kill prey, a cheetah grasps the throat of its prey until it suffocates—a tactic other big cats employ only when killing prey far larger than themselves. Other features of the cheetah's skull also differ from other cats. And, of course, their speed sets them apart from other felids.

Susan Lumpkin

These cheetahs are feeding on a Thomson's gazelle, the preferred prey of cheetahs living in the Serengeti. In other areas, cheetahs take springbok, impala, or various other gazelle species. (John Cavallo)

As a result, taxonomists have placed the cheetah in a separate genus, *Acinonyx* (from the Greek *akaina*, a thorn, and *onyx*, a claw, which refers to the cheetah's unsheathed claws). *Acinonyx jubatus* is the only living species, and scientists have long been puzzled about its relationship to other cats. Recently, however, studies of the molecular biology of cats, coupled with the discovery of fossil cheetahs in North America, have clarified the cheetah's evolutionary history.

Studies of molecular biology by Stephen O'Brien and his colleagues show that the ancestors of the cheetah, as well as of the puma, split from those of other big cats (clouded and snow leopards, tigers, lions, leopards, and jaguars) about eight million years ago. This means that the cheetah belongs to the big cat, or *Panthera*, lineage, and is more closely related to the big cats (although still rather distantly) than to small cats, such as the wild species from which our domestic cat was derived or the ocelots and margays of Central and South America.

The genetic affinity between pumas and cheetahs supports the hypothesis that cheetahs may actually have originated in North America and then spread into Eurasia and eventually Africa. At least two species of cheetah, *A. (Miracinonyx) studeri* and *A. (M.) trumani*, are known to have lived in western North America. (*Miracinonyx* is a subgenus, indicating the closer relationship between the North American species. The name comes from the Latin *mirus*, which means surprising or amazing, as the discovery of these North American cheetahs was to the scientists who identified them.)

Studer's cheetah was the older and larger of the New World cheetahs, first appearing in the fossil record of about three million years ago, at the beginning of the Pleistocene, although it or another *Acinonyx* probably existed four to five million years ago. Studer's cheetah eventually gave way to the smaller *trumani* species, which survived in North America until the end of the Pleistocene, about 10,000 years ago.

The giant cheetah, *Acinonyx pardinensis*, was a very large cheetah of Eurasia, weighing 210 pounds or more, compared to an average of about 125 pounds for today's *A. jubatus*. This species appears in the fossil record of France about three and a half million years ago. The giant cheetah was widely distributed in Europe, and appears in both India and China. About the size of a lion, this cheetah was probably as suberb a runner as the living cheetah, causing paleontologist Bjorn Kurten to remark that the giant cheetah "on the hunt must have been a fabulous sight."

Scientists believe that there was a gradual transition from the giant cheetah to the smaller, living species, which reached its current size in the mid to late Pleistocene. Many mammals, including lions, bears, and rhinos, decreased in size throughout the Pleistocene era. Until the end of the Pleistocene, cheetahs remained widely distributed in Europe and Asia, as well as throughout Africa and the Middle East.

The three fossil species and the living cheetah are all strikingly similar in form and all show adaptations for using high speed to capture prey. In the North American species, however, these adaptations and a few other anatomical features are more primitive, suggesting that the North American cheetahs were ancestral to the Eurasian and African ones.

The most likely path for the movement of cheetahs from North America to Eurasia (and ultimately into Africa) was through the land bridge that connected western Alaska with eastern Siberia during the Pleistocene, forming a vast region known as Beringia. Under the much different climatic conditions of the Pleistocene, this region was a very cold, very dry grassland/savanna. It supported an array of species now more often associated with dry tropical grasslands, including lions, wild horses, hyenas, and, most important from the cheetah's perspective, a variety of antelope and deer that may have served as prey. Some speculate that the great speed of pronghorn antelope, considered the fastest land mammals after cheetahs, may have evolved in response to cheetahs.

Forever Rare

Despite their once very wide distribution, cheetahs seem never to have existed in large numbers. Compared to lions, for instance, cheetahs appear relatively rarely in the fossil record. Even before the collapse of the cheetah's range in this century, 19th-century European explorers and travelers to the Middle East and Africa reported only rare sightings of cheetahs. Norman Myers esti-

Gazelles

One of the main reasons for the cheetah's decline is the decline of gazelles and other hoofed prey in a large part of their former range. Like cheetahs, gazelles once flourished through much of Africa and the Middle East, as well as in parts of Asia. Today, hunting and habitat loss are killing off most species of gazelles in the wild, and populations in zoos are also dwindling.

Gazelles range in size from the dorcas gazelle (*Gazella dorcas*), which weighs as little as 33 pounds, to the dama gazelle (*Gazella dama*), which weighs up to 187 pounds. Slender and long-legged, most gazelles are pale brown with white undersides. Another feature common to these elegant animals is their "stotting" or "pronking" gait—when playing or alarmed, gazelles bounce along stiff-legged, landing on all fours between bounces.

Because most gazelles live in semidesert steppes, mountainous desert scrub, and other remote, arid habitats, these animals are little known. In fact, even their taxonomy (classification into species) is controversial. Some biologists think there are 11 species in the genus *Gazella*, while others think there are 14 or 16. The number of subspecies is also in dispute. Many species of gazelles are divided into isolated populations by geographical barriers including mountains, the Red Sea, and the Persian Gulf. The form of these isolated populations can vary dramatically over a species' range. Notably, while dorcas gazelles are pale with fairly straight, parallel horns in Morocco, they are smaller and reddish with lyre-shaped horns in India; populations between these two regions have intermediate characteristics.

Although the taxonomy of gazelles is uncertain, one thing about them is clear: They are in trouble. The numbers and ranges of most gazelles have declined greatly and the World Conservation Union (IUCN) listed all but one species as vulnerable or endangered in 1990. The only abundant species is Thomson's gazelle (*Gazella thomsoni*), a small East African gazelle that, unlike most members of its genus, lives in grassy plains.

Gazelles in arid regions are dying out in part because people are taking over their habitat. People displace gazelles from springs, let domestic sheep and goats overgraze areas where gazelles used to feed, and convert land to agriculture.

Still abundant in East Africa, Thomson's gazelles are the only gazelle species not currently in danger of extinction. (Carol Cofey)

Most widely distributed of the gazelles, the dorcas gazelle suffers from overhunting and habitat loss throughout its range. (Jessie Cohen/NZP Graphics)

While crops can actually improve the habitat for gazelles, farmers view them as pests and try to eradicate them.

Another major reason for the gazelles' recent decline is that sport hunting has increased since World War II, when rifles became more readily available. Gazelles are easily hunted from vehicles, and hunting has decimated populations of dorcas gazelles and slender-horned gazelles (*Gazella leptoceros*) in the western deserts of Egypt. If hunting is limited, however, people and gazelles may be able to coexist. Populations of dorcas gazelles near agricultural settlements in Israel have increased by an average of nine percent annually for 20 years.

In addition to protecting gazelles and their habitats, there is an urgent need for zoo breeding, says Oliver Ryder of the San Diego Zoo's Center for Reproduction of Endangered Species (CRES). "Relying solely on the strategy of protection in the wild is not enough," he says, cautioning that "zoo breeding reinforces—but does not replace—conservation in the wild."

However, zoo gazelle populations are also declining in part due to reduced reproductive fitness. One species that has not reproduced well in zoos is Soemmerring's gazelle (*Gazella soemmerringi*), a pale gazelle that lives in the bush and acacia steppe of northeast Africa. The zoo population of this gazelle has variable numbers of chromosomes, ranging from 34 to 39. Researchers at CRES have found that the variation is due to structural rearrangements of three chromosome pairs. The total amount of genetic material remains the same, but it is now packaged in a different way.

Scientists believe that the chromosomal differences found among Soemmerring's gazelles in zoos account for their poor reproductive record. When egg and sperm are united to form an embryo, the genetic material contributed from the dam and the sire must combine. When animals of differing chromosomal constitutions are bred, the chances of correct genetic combination are reduced, leading to reduced fertility, explains CRES researcher Arlene Kumamoto.

Ryder speculates that the founder stock of the zoo population of Soemmerring's gazelles included either gazelles from different taxa (species and subspecies) or hybrids between taxa. "Maybe people didn't have much experience with what Soemmerring's gazelle look like. Gazelles look a lot alike—they're the mammalian equivalent of little brown birds," he says. Soemmerring's gazelle and Grant's gazelle (*Gazella granti*), for example, are easily confused and their ranges overlap. Thus, before pairing zoo gazelles for breeding, biologists need to know where the animals were captured as well as the number and structure of their chromosomes.

Besides including gazelles that may have been misidentified, the founder stocks of most zoo gazelle populations were very small. There were only four animals in the founder stock of the zoo population of Speke's gazelle (*Gazella spekei*), a pale, little-known gazelle from the bare, stony steppes of the Horn of Africa. While introducing new founder stock is essential to avoid the deleterious genetic effects of inbreeding, getting wild-caught gazelles is difficult. "Many gazelles are from North Africa and the Middle East, where there has been such turmoil and conflict. In addition, U.S. quarantine restrictions and CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) regulations make it difficult to import animals," notes Kumamoto.

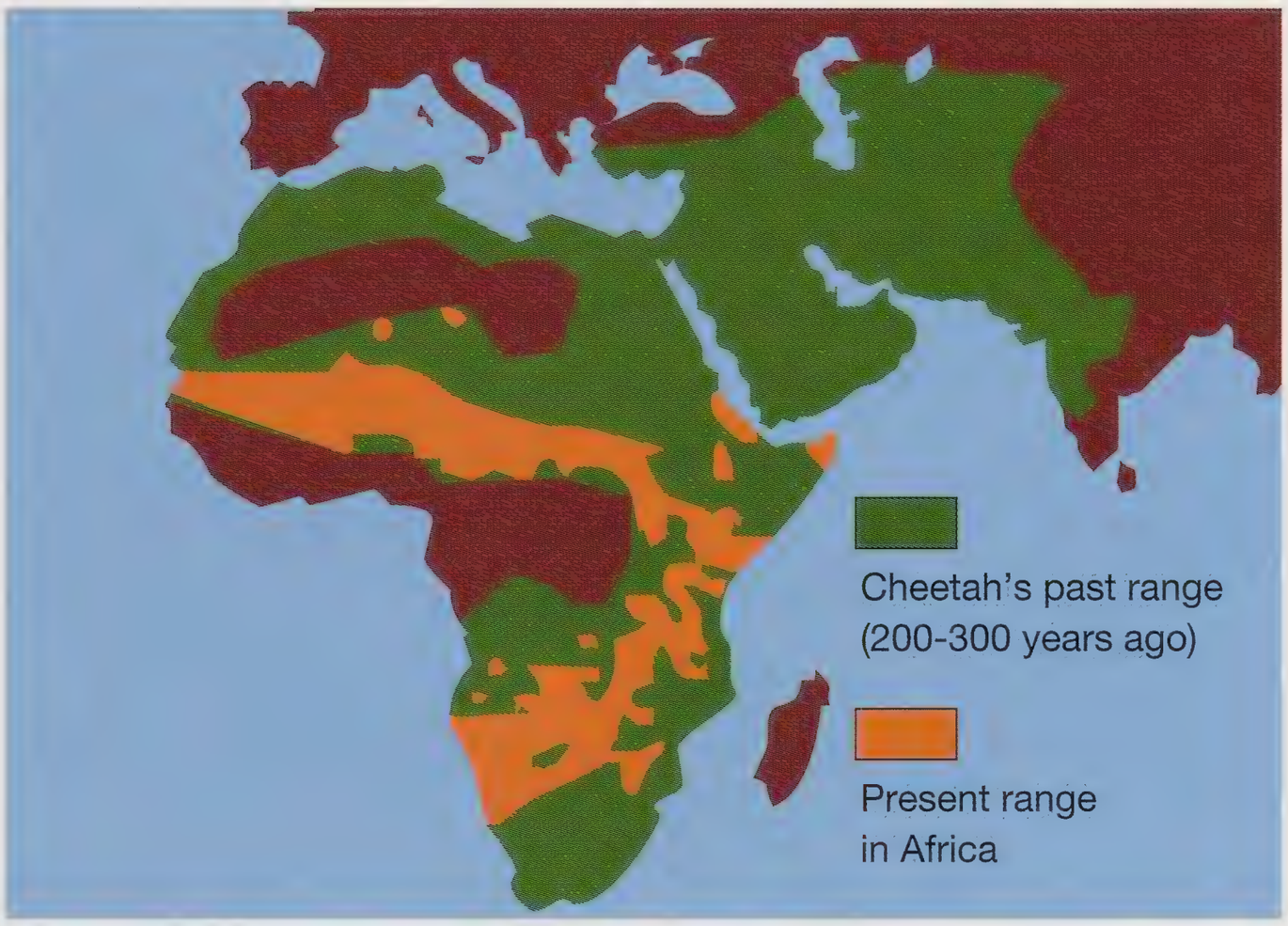
The future for gazelles looks bleak. "Although more attention has been drawn to gazelles recently, their situation is not unique," says Ryder. In other words, gazelles are competing with other threatened and endangered wildlife for limited conservation resources, and there may not be enough to go around.

—Robin Meadows

mates that perhaps no more than 100,000 cheetahs lived in "pristine" Africa south of the Sahara, based on an average of one cheetah per 30 square miles in prey-rich savanna habitats and only one cheetah per 90 to 185 square miles in less productive, more arid environments. Today, even in protected areas such as Tanzania's Serengeti National Park where densities reach one cheetah per about six square miles, cheetah densities are low compared to those of lions and spotted hyenas. And, in only a few places, such as Namibia, where lions and hyenas have been virtually exterminated by farmers, are cheetahs relatively abundant.

As big cats go, cheetahs, with their slight builds and small canines, are fairly ill-equipped to defend themselves against predators. And, throughout their current and historical range, cheetahs have lived among larger or more powerful predators, including lions, hyenas, wild dogs, and leopards. Adult cheetahs are victims of predation, particularly by lions, but cheetah cubs are especially vulnerable. In Serengeti National Park, about 90 percent of all cubs die before they are three months old, and half of these deaths are due to predation.

Cheetahs also lose prey to these larger carnivores in their range. In the Serengeti, for example, cheetahs lose between 10 and 13 percent of their kills. Alerted by the panic of the gazelle herd or by the circling of vultures, lions and hyenas close in on a cheetah's kill and easily drive the timid cheetah away. Cheetahs thus need to eat fast, but they also need to rest and cool off after a chase. The cheetah's blinding speed in pursuit of prey pushes the cat to its physiological limits. Lacking a mechanism for evaporative cooling to maintain a constant body temperature while running, cheetahs store the large amount of heat produced by a high-speed sprint. This is why cheetahs must catch their prey or abandon the chase after sprinting about 300 yards—after this point, body temperature would rise to lethal levels.



Above: *Cheetahs disappeared from most of their range during the last 50 years.*

The presence of other predators thus helps keep cheetah numbers low, creating a paradoxical conservation dilemma for managers of protected areas who wish to increase populations of all endangered predators.

Behavioral Ecology

Contributing further to low numbers of cheetahs is the very high rate of adult deaths due to combat be-

Left: *By about four months of age, cheetah cubs have lost the black belly fur and light gray, very woolly mantle they are born with. This distinctive natal coat may help camouflage the cubs until they are agile enough to outrun most predators.* (JoGayle Howard)

Cheetahs run using a rotary gallop: The hind legs land first on alternate sides; then no feet touch the ground as the cheetah literally floats through the air. Next, the front legs land on alternate sides, then the cheetah goes into "crossed flight," with all four feet gathered under its body and off the ground.

(Sam Wasser)

tween males, which has only recently been documented. Scientists began systematic studies of cheetahs only about 30 years ago, despite thousands of years of close association between cheetahs and people. The most extensive research has been on cheetahs in Serengeti National Park. These studies were initiated in the 1960s by George Schaller and have been conducted over the past decade by Tim Caro, now of the University of California at Davis, and his colleagues and students. Their work has produced a fascinating picture of the lives of predators in peril.

Female cheetahs are typical solitary cats, living alone or with their young cubs. Interactions with males are rare, confined to brief mating periods of a day or two. Adult females also avoid other females, although the home ranges of females may overlap extensively because the ranges are too large for a female to effectively defend. In the Serengeti, where Thomson's gazelles make up about 90 percent of a female cheetah's diet, females annually range over more than 300 square miles as they follow the gazelles' migrations across the savanna.

About 40 percent of adult males also live alone, but the rest live in all-male groups, or coalitions, of two, three, or sometimes four. Lasting throughout the lifetime of the males—up to eight years in the wild—these coalitions are usually made up of littermates, but about 30 percent of the coalitions include unrelated males. Like females, most males, whether alone or in coalitions, wander over large areas of the Serengeti following migratory gazelles as well as the larger wildebeest preferred by coalitions. But about 30 percent of coalitions remain resident on small, 15-square-mile territories that they aggressively defend against other males.

In the entire Serengeti, no more than 10 territories are occupied at any one time. The territories contain cover, either vegetation growing in riverbeds or tall, rocky outcrops. Each year during the wet season, when most matings occur, female cheetahs gather in the territories to take advantage of both the cover and the gazelles that also concentrate in this habitat. With as many as 20 or 30 females ranging in these "hot spots," territory-holders enjoy more mating opportunities than wanderers, leading to fierce and often fatal battles between coalitions over ownership of territories. This also explains the value of coalitions—larger groups are better able to secure and defend a territory than smaller groups or singles.

After mating, a female cheetah gives birth 90 to 95 days later to as many as eight, but usually three to five cubs. Born blind and helpless, the cubs remain hidden in a den of thick vegetation for six to eight weeks. This period is fraught with danger for the young cubs. The mother conceals the cubs and is extremely vigilant to avoid attracting predators to the den, but she must also hunt and may have to be away from the den for up to 48 hours to feed herself and acquire the additional energy to support lactation. As noted above, many defenseless cubs are lost to predators, but other causes of death include grassfire, exposure, disease, and sometimes maternal abandonment if prey is scarce and the mother cannot find enough to eat.

Even after cubs begin to follow their mother on hunts they remain vulnerable, largely due to their inexperience at predator detection and recognition. Cubs also lack the speed of adult cheetahs and cannot

run fast enough to escape danger. The antics of cubs may also reduce the female's hunting success, as they "blow her cover" during a stalk—one study showed that between 16 and 21 percent of a female's hunts failed due to cub activity.

Cubs only very slowly learn to be effective hunters, and even after they leave their mother at between 14 and 18 months of age, they are still not very proficient for another year or more. To reduce risks and avoid harassment from other carnivores, all cubs stay together for about six months after leaving their mother. Then, females go off to live alone, while males, if they are fortunate enough to have surviving brothers, stay together to form adult coalitions. But high rates of mortality continue: Half of the males that survive to independence die before reaching adulthood (two and a half to three years of age), largely due to combat with other males over territories.

Above: *The presence of vultures may signal to lions and hyenas that a cheetah's prey is available for the scavenging.* (John Cavallo)

Rise and Fall

Climate change at the end of the Pleistocene, which brought about massive extinctions, mostly of large mammals, most likely accounts for the extinction of the American cheetah and the disappearance of cheetahs (*A. jubatus*) from Europe and parts of Asia. In much of Europe, for instance, forests replaced the open grasslands that cheetahs and their prey are adapted to. Evidence of a "genetic bottleneck" at the end of the Pleistocene suggests that cheetahs also neared extinction throughout their range in Africa and Central Asia, where grasslands and semideserts remained.

But cheetahs recovered and in historic times ranged wherever dry, open habitat existed in Africa from north to south, in the Middle East and Central Asia, and as far east as central India. Since about the middle of the last century, however, the cheetah's range has rapidly and inexorably declined. Cheetahs were declared extinct in India in 1952, and have not been seen in the vast Arabian Peninsula since 1950. A few might have survived until recently in Central Asia, especially in Iran, but most people believe they are now extinct there. Cheetahs were extremely rare in North Africa by the 1960s and are now gone. A 1970s survey estimated that only 14,000 existed in all of Africa, down from about 28,000 15 years earlier and from a precolonial number of 100,000. Today, cheetahs survive in just a few isolated areas in Africa south of the Sahara.

Cheetahs disappeared from India, Central Asia, the Middle East, North Africa, and the Sahel largely as a result of uncontrolled hunting of both cheetahs and their principal prey—blackbuck in India, and dorcas, dama, and other gazelle species elsewhere (see sidebar on gazelles). The movement of pastoralists, mostly sheep herders, into cheetah habitat also contributed to the decline, primarily because the herders kill the cheetahs that threaten their domestic animals. (Ironically, grazing lands make excellent habitat for cheetahs if people could only learn to live with them.) In sub-Saharan Africa, colonial European ranchers and farmers, and the Africans who are converting pastureland to farmland, have made habitats unsuitable for cheetahs. Trade in cheetah skins, which is now banned in most countries but continues on the black market, also played a role in the cheetah's decline.

Effective protection in reserves and national parks may be sufficient to save many endangered species, at least in the short term. But, as noted above, even protection is a mixed blessing for cheetahs, who are threatened by large numbers of predators. New and creative ways of conserving cheetahs in the wild, coupled with zoo breeding programs to create a back-up, are essential if these elegant creatures are to survive. ✤

Left: *Female cheetahs live alone or with their cubs, but adult males often live in groups of two, three, or four. The males in these groups, called coalitions, are usually brothers.* (Jean B. McConville)

Cheetah Conservation Station

A cheetah shoots up the grassy hillside and we all gasp. Even Zoo and FONZ staff who have worked with animals all their lives thrill at the sight of this beautiful spotted cat. All are smiling and moving briskly along the walkway to watch the cheetah's first plunge into his new home at the Cheetah Conservation Station (CCS).

"What a magnificent creature," exclaims Zoo Director Michael Robinson, who literally skips up the path as the cheetah leaps to higher ground.

Then a second cheetah bounds up the hill to join his brother. Both take a careful look around. Big brown eyes and erect ears intently follow passersby. Strange sights and sounds—the rumble of big yellow schoolbuses seems particularly provocative—send the cheetahs into their famous sprint. Finally, more comfortable now, the brothers sink into the tall grass, their small heads just peeking over the waving, bright-green blades.

As I watch, I recall seeing cheetahs in the wild. Once, in Kenya's Masai Mara Reserve, five orphaned cubs circled our jeep and sidled up to its tires like they were mom's belly. I remember cheetahs lounging in the sparse shadows of thorn acacias on still, hot mornings in northern Kenya's Samburu National Park. On Tanzania's Serengeti Plain, I watched a solitary cheetah elegantly descending from a lone rock outcrop. Countless zebras, wildebeest, and gazelles dotted the volcanic short-grass vista, as bright-green as a golf course. The cheetah stalked toward the first stand of zebras, then lowered its belly into the grass, disappearing from sight. And we, less vigilant than the cheetah, were distracted by the flapping and strutting of secretary birds on the muddy road.

Watching the Zoo's cheetahs glide a car-length in midair, then land gently on another hilltop, I think, but dare not say aloud in such zoologically astute company, "They are acting just like cheetahs!" And indeed, short of taking an East African safari, people will have no better opportunity to see these remarkable cats in action. The new exhibit, planted with 35 species of grass to simulate grassland habitat, also offers a look at some of the species that share that habitat: dorcas and dama gazelles, which are species that cheetahs prey on; Grevy's zebra, largest of the living species of zebra; and colorful African crowned cranes.

Next page: *African crowned cranes (Balearica regulorum) share an exhibit area with dama gazelles at the Cheetah Conservation Station.* (Jessie Cohen/NZP Graphics)

Ruth Stolk

But the Cheetah Conservation Station is not designed merely to display cheetahs (which will eventually number 10 adults) and their potential prey. At the Station, Zoo scientists will study the behavior, genetics, and reproductive physiology of cheetahs as part of a massive effort to save this endangered species from extinction. What's more, the Station offers visitors a window into this state-of-the-art scientific endeavor as they gain a real understanding of cheetahs through entertaining interactive activities. (My favorite is "What's For Dinner?", in which visitors are invited to weigh themselves, then determine how much of a dent they would put in a cheetah's minimum daily requirement if they were hoofed mammal prey.)

Below: *Found only in northern Kenya and parts of Ethiopia and Somalia, Grevy's zebra (*Equus grevyi*) are rare and continue to decline, primarily due to excessive trophy hunting.* (Mark Rosenthal)

Slender Sprinters

In Tanzanian cave paintings uncovered by paleontologist Mary Leakey, cheetahs can be identified by their small heads, long tails, and lean, muscular bodies. A Zoo visitor comments that one of the male cheetahs looks too thin, but Stuart Wells, biological technician for the Cheetah Conservation Station, responds that he's supposed to look that way.

"Cheetahs are lean and tall and built for speed," he says. "Everything about them is designed to do what they do—run fast. Their legs are long, their spines are flexible, and they run on their toes. Besides that, a deep chest to draw deep breaths for the sprint makes the cheetah's waist look thinner than it is."

All cats have bodies designed for speed. They walk and run with only their toes touching the ground (called digitigrade stance), have flexible spines, and high, mobile shoulders. Cheetahs just carry these features to the extreme. Compared to other cats, their feet and leg bones are straighter, their shoulders and limbs are longer, and their spines are longer and have larger muscles for flexing and stretching. The long tail acts like a rudder to increase maneuverability while sprinting. Cheetahs are also slimmer and lighter than other big cats, weighing only 86 to 143 pounds, compared to as much as 500 pounds for a big male lion.

As a result, a cheetah may reach speeds of nearly 70 miles per hour, faster than one can legally drive on the highway. Even more impressive is how quickly a cheetah accelerates. According to Wells, a cheetah can actually beat a Ferrari GTO off the line. The high-performance sports car needs four seconds to reach 50 miles per hour, while the cheetah hits 50 in less than three seconds. Unlike a car, however, a cheetah can go at top speed for only about 300 yards and then may need 30 minutes or more of rest to recover from the effort.

Cheetahs use this great speed to capture the gazelles and other antelope such as impala and wildebeest that make up their prey. At the Cheetah Conservation Station, children (and brave adults) can run and prowl along a predator/prey trail, imitating a cheetah stalking a gazelle. In addition, daily demonstrations, narrated by trained FONZ volunteers, of a cheetah running along a lure course offer visitors the chance to see how fast cheetahs run—and it has to be seen to be believed!

Under the Skin

For those of us whose experience of observing chee-

The "Hunting Leopard"

The cheetah's first recorded association with humans dates to more than 4,000 years ago. A collared cheetah adorns a silver vase, dated from about 2,300 B.C., that was discovered at Maikop in the Caucasus. A rock painting in Tanzania, in which a cheetah is seen among seven dancing women, may be even older. Other groups including the Scythians, Assyrians, Egyptians, and Indians also left evidence of taming cheetahs. And, Europeans coursed cheetahs during the Renaissance.

Although the cheetah's beauty is indeed remarkable, early humans probably were attracted to the animal's hunting behavior rather than its appearance. They no doubt observed that cheetahs are often chased away from a kill by other predators and scavengers. Noting this, our ancestors probably did the same thing. Finding that cheetahs are docile and trainable, humans eventually put them to work as hunters. This is a fairly typical scenario for the early stages of domestication. However, the cheetah's refusal to breed in captivity may have prevented full domestication.

The Mughal emperors of 16th-century India were without doubt the all-time cheetah aficionados. Although earlier records describe cheetahs being used to hunt, Mughal histories provide an example of the cheetah's esteemed place in society. The Mughal emperor Akbar reportedly trapped cheetahs in pits and trained them for the hunt and for life in the palace, keeping as many as 3,000 cheetahs at one time.

As has been the case throughout history, the Mughal emperors had little luck breeding cheetahs. One cheetah birth occurred in 1613 when an uncollared male cheetah from Akbar's collection mated with a female who later delivered three cubs. Imperial historians viewed this as a "strange" event, and entered it in the record books. No further cheetah births in captivity were reported until 1956, when three cubs were born at the Philadelphia Zoo.

Bridgeman/Art Resource, N.Y. Not in deposit; PHD 548. George Stubbs. Cheetah with Indian Attendants *(#1 detail). Manchester City Art Gallery.*

What fascinated Akbar was the hunt. According to one story, as he and his special cheetah hunted, a deer leapt across a 25-yard ravine at the height of "a spear and a half," making a kill unlikely. Chitr Najan, as the cheetah was named, raced after the deer, leaping over the ravine to seize his prey. As a result, he became chief of the cheetahs, and "as a special honour, and as a pleasure to men," Akbar ordered that a drum should be beaten in front of the cheetah.

As recently as 1941, John and Frank Craighead, on assignment for *National Geographic* as guests of an Indian prince, observed trained cheetahs, known as "hunting leopards," hunting blackbuck on the coastal plains of the Indian state of Bhavnagar. The cheetahs were driven to a herd of blackbuck in a sturdy truck. Trainers kept the animals hooded until the truck drew near to the herd. When the trainer removed a cheetah's hood, the animal burst from the vehicle in pursuit of its quarry.

As described by the Craighead brothers, "the cheetah had timed his run, saved his wind, and counted on the spurt...what had appeared like a speeding ripple was now a straight line hurtling toward the buck so fast that it appeared as if only one object were moving. The cheetah was doing close to 70, possibly 80 miles an hour, and looked like a blur of brown against a tan background."

During this chase, the blackbuck dodged the cheetah three times, but the cheetah eventually tripped him up with a well-aimed front paw to the hind leg. The cheetah then sprang and closed his jaws on the buck's neck. At this point, "the trainers rushed in and with a Mohammedan prayer they finished the struggle."

Whether for its awesome speed and hunting skills, or for its aesthetic appeal, the cheetah has long been a favorite of humans. Given the profound nature of the cheetah's present dilemma, it appears that the relationship between humans and cheetahs is of more consequence now than at any other time in history.

—Christopher Stuart

tahs is limited to a brief glimpse through binoculars, it is amazing that scientists looking through powerful microscopes at a tiny blood sample can perceive the chain of life that makes a cheetah a cheetah. At the CCS, visitors can learn how and why scientists at the National Zoo's NOAHS (New Opportunities in Animal Health Sciences) Center are doing this.

In the early 1980s, NOAHS' Stephen O'Brien, David Wildt, and Mitchell Bush discovered that cheetahs exhibit extraordinarily low levels of genetic diversity—in the wild and in zoos, cheetahs are all virtually identical twins. O'Brien believes that the inbreeding that created this situation began about 10,000 years ago as a result of what is called a "genetic bottleneck." For unknown reasons, the African cheetah population must have crashed and been close to extinction. O'Brien speculates that perhaps only one female and her cubs survived to begin slowly rebuilding the population. But the reduced genetic diversity that resulted from this inbreeding has serious consequences for the cheetah, producing infertility, high infant mortality, and an inability to combat infectious disease.

Cheetahs are highly susceptible to disease agents. For example, an outbreak of feline infectious peritonitis virus may kill 50 to 60 percent of cheetahs affected, compared to one to five percent of genetically diverse domestic cats.

"You can view a cell like a fortress," says O'Brien. A virus is an army attacking the fortress. With high levels of genetic diversity, or "genetic plasticity" as O'Brien calls it, the army has to overcome many hurdles to take the fortress. When diversity is absent, so too are the multiple hurdles and the cell is easily taken.

Cheetahs also suffer from infertility, a result of inbreeding's effect on male sperm cells. NOAHS scientists, led by David Wildt, the Zoo's head reproductive physiologist, have examined sperm from both wild and zoo cheetahs. "We were amazed to find that up to 70 percent of cheetah sperm is abnormal," says Wildt. "In most animals, more than 20 percent abnormality is a sign of infertility."

Now home to a pair of four-year-old brothers and two eight-month-old cubs, a male and a female, the Cheetah Conservation Station will eventually include 10 cheetahs. (Jessie Cohen/NZP Graphics)

Problems and Solutions

Cheetahs are notoriously reluctant to breed in captivity. Despite concerted efforts, the Mughal Emperor Akbar failed to breed cheetahs. The one breeding recorded among his thousands of cheetahs was the result of an accidental encounter between a male and female. But the cubs died. North American zoos began to experience some success in breeding cheetahs in the early 1960s, and, despite infant mortality rates as high as 37 percent, the North American zoo population reached about 200 animals by the mid-1980s, including cheetahs imported from the wild and from foreign zoos. By 1986, however, the zoo birthrate had declined by 50 percent and, with cheetahs endangered in the wild, the possibilities of importing new cheetahs to supplement the zoo populations were sharply reduced.

Deeply concerned, participants in the Cheetah Species Survival Plan (SSP), one of 56 such plans coordinated by the American Association of Zoological Parks and Aquariums, called for intensive and wide-ranging research on cheetahs to ensure their survival in zoos. To keep track of cheetahs in zoos, NOAHS associate Laurie Marker-Kraus keeps *The Cheetah Studbook*, a world registry now in its third annual edition.

Says Jack Grisham, SSP coordinator and a curator at the Oklahoma City Zoo, "The purpose of the research is to enhance the fecundity, reduce the mortality, and produce a self-sustaining population that can be managed as a back-up to ensure the survival of cheetahs in the wild." NOAHS scientists are leading this research effort, and as a result the Cheetah Conservation Station was selected as an intensive research site.

Cheetahs use a variety of vocalizations to communicate. Some are used only between a mother and her cubs. She uses these to call up lost cubs, to encourage them to follow her, and to tell them to keep still.

(Miles Roberts)

Part of this effort includes ongoing research to improve breeding through artificial reproductive technologies. For instance, JoGayle Howard, a Zoo reproductive physiologist and veterinarian, took NOAHS' high-tech "Mobile Lab" (see "Frontiers," *ZooGoer*, July/August 1990) to the Caldwell Zoo in Tyler, Texas, which maintains a large group of cheetahs. Howard successfully artificially inseminated a female cheetah, who gave birth to a cub. Unfortunately, the mother, upset by a storm, accidentally killed her cub, but Howard is now working to repeat her success at other Texas zoos. And soon, work will get underway at the Cheetah Conservation Station.

Howard and other NOAHS scientists are also working on cryopreservation (freezing) of sperm and eggs so these germ cells can be saved for future artificial reproduction. "The only way we're going to save the cheetah is to learn as much as we can," says Howard. "At the CCS we will be able to do comparative semen cryopreservation studies. Cryopreservation will allow movement of germ cells without our having to take the risks of moving live animals from one location to another."

Other scientists will study behavior, nutrition, and endocrinology at the CCS. Regular, ongoing collection of data on the cheetahs' behavior is a special focus, and Stuart Wells has already trained a cadre of FONZ volunteers to conduct behavioral observations. Studies of how the size and sex composition of cheetah groups affect breeding will be particularly important as Zoo scientists attempt to incorporate Tim Caro's findings on cheetah social behavior in the wild (see pages 15-17) to the zoo management program. No longer is it simply a matter of exhibiting cheetahs "two by two," as was so often done in the past.

"We know so much more than we did even a year ago," says Zoo Curator of Mammals John Seidensticker, who managed the transformation of the old hoofstock area into a full-fledged conservation research site, as well as a fascinating educational exhibit for the public. "The National Zoo is poised to lead the way in producing cheetah young using the latest technologies to assist in natural reproduction and to boost the population using artificial reproduction."

"This is an enormous challenge," Seidensticker adds, "but now we believe many things are possible that were only dreamed of one year ago." ✤

Ruth Stolk is the Executive Director of the National Zoo's NOAHS Center.

Left: *The cheetah's distinctive black tear stripe may serve as an antiglare device, like the black marks quarterback Joe Theismann wore under his eyes. Or, the stripe may enhance the facial expressions cheetahs use to convey aggressive or submissive intent to other cheetahs.*

(John Cavallo)

In addition to federal funds, contributions from Steiff USA, The Bardes Fund, the Theodore H. Reed Animal Fund (proceeds from Friends of the National Zoo's ZooFari), the Founding Members of the Director's Circle, The Scale People, Inc., Pennsylvania Scale Co., Brandywine Enterprises, the Prince William Cannons, Ms. Jane W. Gaston, and Mr. Jeffrey Short helped to make the Cheetah Conservation Station possible.

A generous contribution from Steiff USA, makers of exotic plush animals for more than 100 years, will support the opening of a Cheetah Conservation Theater in the spring of 1993.

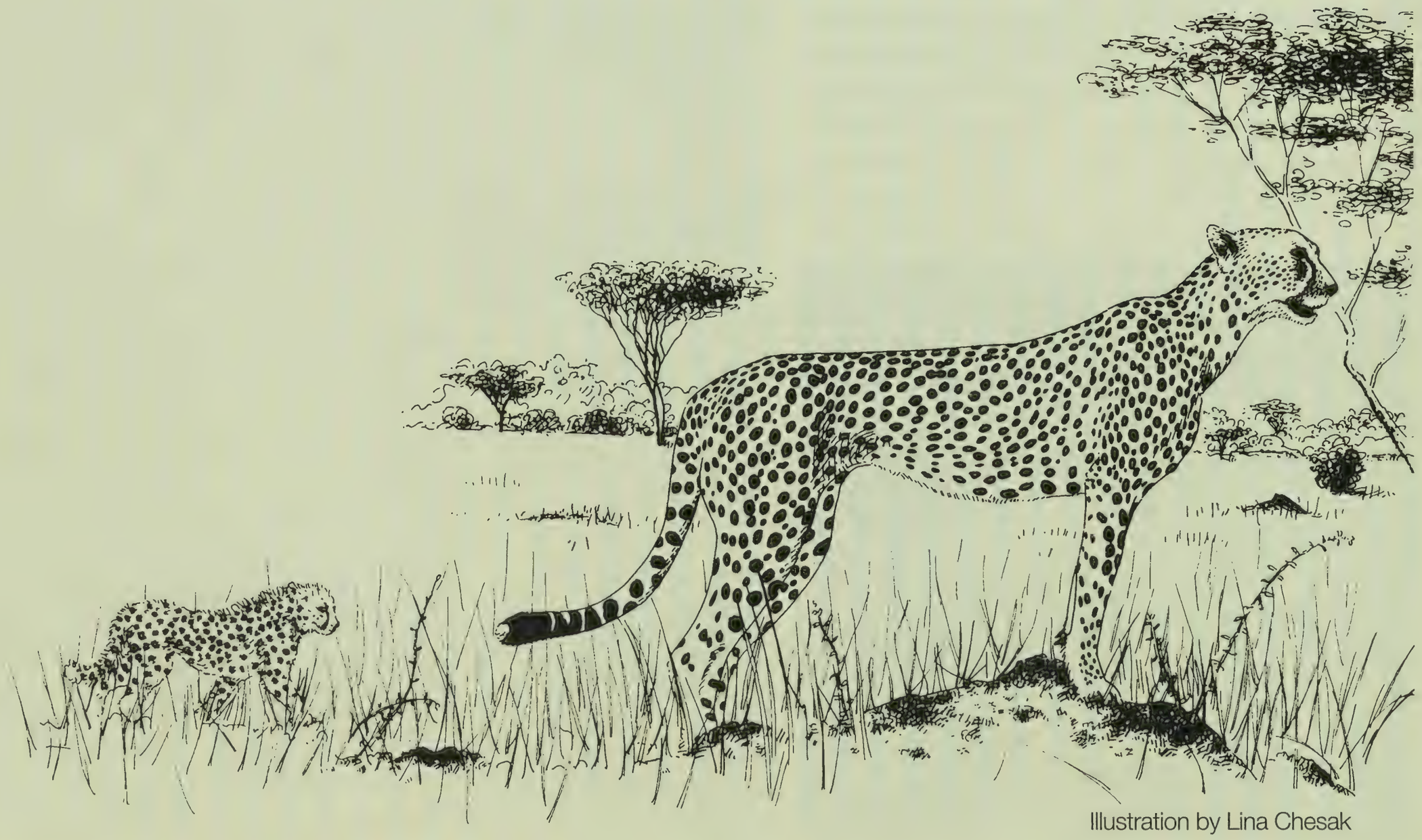


Illustration by Lina Chesak

THE TAXONOMIC TWIST

A poacher's gun, a clear-cutter's chainsaw: In addition to these threats, another problem plagues some endangered animals. It has to do with their genes. Take the case of the dusky seaside sparrow (*Ammodramus maritimus nigrescens*), a subspecies that once lived in the salt marshes of east-central Florida. This small songbird dwindled in numbers in the 1970s as the marshes were flushed with freshwater to control mosquitoes. In 1980, the last known duskies were taken out of the wild in an effort to preserve the subspecies through a breeding program. Because the four remaining birds were all males, conservationists decided to cross them with female Scott's seaside sparrows (*Ammodramus maritimus peninsulae*), a nonendangered related subspecies.

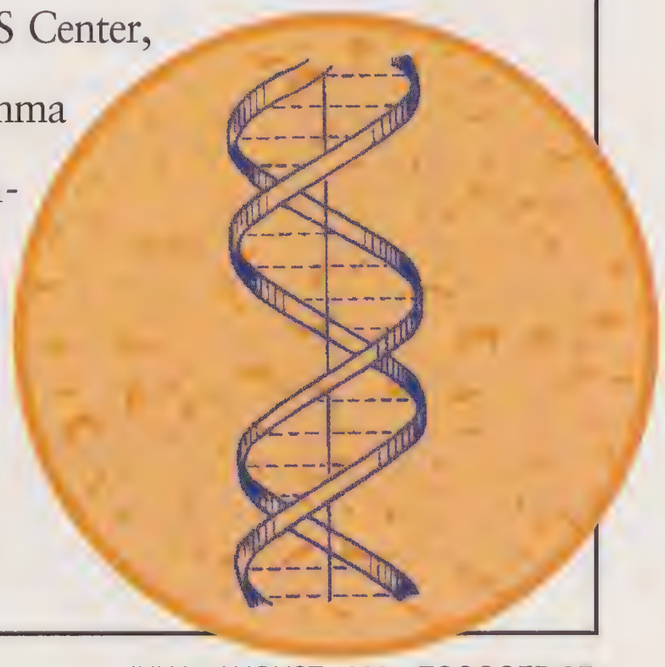
The effort backfired. Under the U.S. Endangered Species Act, hybrid offspring were not eligible for federal protection, so the breeding program lost its funding from the Interior Department. By the late 1980s, the dusky seaside sparrow was extinct.

Soon after the sparrow's demise, a new technique emerged that changed people's ideas about species. Scientists began examining endangered species' genetics using biochemical techniques, in particular mitochondrial DNA (mtDNA) analysis, to unlock their genes' secrets—level of inbreeding, evolutionary history and relationships, and extent of hybridization. (For explanation of mtDNA analysis, see box on page 28.)

In fact, scientists studying the mtDNA of dusky seaside sparrows, red wolves, Florida panthers, and other endangered animals have stirred up a debate over the definition of species and subspecies and the relationships between them. Furthermore, these recent findings have ignited a heated argument over which animals should receive federal protection and which should be left to fend for themselves.

The mtDNA of some animals revealed unwelcome surprises: Hybrids popped up in unexpected places. Haunted by the ghost of the dusky seaside sparrow case, scientists grew concerned about evidence of hybrids involving endangered animals. "It got to the point where geneticists were wondering if they should publish their data showing hybridization," says Stephen J. O'Brien of the National Cancer Institute in Frederick, Maryland. O'Brien, who is also codirector of the National Zoo's NOAHS Center, found himself in a similar dilemma over data on another endangered subspecies, the Florida panther (*Felis concolor coryii*).

STORY BY MELISSA BLOUIN



Dusky seaside sparrow (left), now extinct, and Scott's seaside sparrow (right): subspecies with a difference. (P.W. Sykes/VIREO [left]; M. Victoria McDonald [right])

The Problem of Pedigree

O'Brien and Melody Roelke of the Florida Game and Freshwater Fish Commission tested the mtDNA of this highly endangered puma subspecies, which is making its last stand in Florida's Big Cypress Swamp with a population of fewer than 50 animals. When O'Brien and Roelke tested mtDNA from blood and tissue samples, they found a distinct pattern in the mtDNA of a few panthers that otherwise occurs only in the South American subspecies. Apparently, a Florida menagerie released a group of panthers in the late 1950s and early 1960s, with permission from the U.S. Park Service, under the mistaken impression that the animals all bore a Florida pedigree. One or more of those animals came from South American stock.

Ironically, the highly inbred Florida panther probably benefited from its dalliance with South American cats, according to O'Brien. The complicated process that creates life produces amazingly few mistakes: In two unrelated panthers that have young, errors in one parent's genes are usually masked by the correct sequence from the other animal's DNA. However, when cousins or siblings mate, they increase the chances of passing on two copies of a defective gene, which could lead to sterility or other defects in their offspring. Their young also have less chance of surviving than the progeny of unrelated parents.

"The purebred Florida panther without new genetic material is in trouble," says Roelke. For instance, one panther survived being hit by a truck, hospitalization, and rehabilitation into the wild only to die a few months later from a heart defect. All of the purebred Florida panthers have a 90-degree kink in their tail vertebrae, and "one hundred percent of the living males have only one testicle," says Roelke. Infertility rates run high among the females. And, more than half of the cubs born in a litter never reach adulthood. The hybrid panthers, in contrast, have straight tails and fewer genetic and reproductive problems.

Species or Hybrid?

The red wolf (*Canis rufus*), another top predator from the southeastern United States, faces a different type of genetic problem. Scientists brought the last red wolves in from the wild in 1976 in an effort to save the species from extinction. Over the past 15 years, zoo and wildlife biologists have worked together to breed the skinny, reddish creatures, and the zoo population now thrives with 150 or more wolves. (The National Zoo currently holds five red wolves, and nine pups have been born here since the program started in the fall of 1990.) In 1986, the U.S. Fish & Wildlife Service reintroduced red wolves into the wild on barrier islands off the Gulf coast and the eastern seaboard. They also let loose a family of seven red wolves in Great Smoky Mountains National Park in the fall of 1991.

To learn about the evolution of these canines, scientists compared the mitochondrial DNA of red wolves with that of coyotes (*Canis latrans*) and gray, or timber, wolves (*Canis lupus*). The mtDNA samples came from the captive red wolf colony, as well as from blood collected from wild red wolves between 1974 and 1976 and from skins collected between 1905 and 1930. They found that the red wolves have either wolf or coyote mtDNA, which indicates that red wolves are hybrids of these two species.

Some scientists, including John L. Gittleman of the University of Tennessee at Knoxville, don't want to spend the money to save a half-breed. Gittleman says he thinks that other animals merit the atten-

With 597 animals and plants on the federal endangered species list and 3,700 more waiting for protection, the question of which species are "good" weighs heavily on the minds of scientists and government officials, who spend their sparsely allotted money carefully.

tion and money that are now going toward protecting the red wolf. "What we have here is a cute, cuddly, charismatic carnivore getting preferential treatment," he says.

Gittleman and many others see a bigger issue behind the red wolf debate: Which species should be saved? This question arises continually in the face of limited funds and increasing numbers of endangered animals. Some species, according to Gittleman, are more ecologically important than others. The red fox and gray fox hunt the same prey as the red wolf and, together with the coyote, cover most of the red wolf's former range, which extended from Florida to Texas and as far north as Arkansas. Therefore, Gittleman argues, the red wolf has no unique characteristics that merit saving.

Other scientists view the red wolf dilemma differently: They call for a reassessment of how species are defined. They contend that hybridization happens more frequently in nature than previously thought, and that hybrid plants and animals can actually enhance an ecosystem.

Protection for Hybrids?

Not only do hybrids occur naturally, but the crossbred progeny can benefit the environment, say some scientists who want to see hybrids fully protected under the Endangered Species Act. Thomas G. Whitham of Northern Arizona University in Flagstaff and his colleagues examined two species of eucalyptus trees, one of which is endangered, in adjacent forests in Tasmania, Australia. Where they meet, the two species produce hybrid progeny. The scientists counted the number of insects collected in a 12-minute period from the parent trees and their hybrid offspring. They found twice as many species of insects and three to four times more individual insects on the hybrids than on the purebred parents, suggesting that hybrids support higher levels of biological diversity than purebred species. If so, there is a strong case for full protection of hybrids under wildlife law.

Many scientists define a species as a group of animals that doesn't naturally mate with similar animals even when they come in contact, or, if they do mate, do not produce fertile offspring. Other definitions exist—and debates rage among scientists over which is correct—but this is the definition incorporated into the Endangered Species Act. However, many exceptions to this definition have recently come to light through mtDNA research.

Recent ecological changes may have led coyotes and wolves to mate in the wild. Gray wolves, once prevalent throughout North America as far south as Mexico, now roam only in a few of the northernmost United States, parts of Canada, and Alaska, due to poisoning, hunting, and timber-clearing for agriculture. In contrast, coyotes, once confined to plains and deserts, have expanded to fill the former range of the wolf. Where coyotes outnumber wolves in their new overlapping territories, scientists have discovered wolves with coyote mtDNA, which indicates hybridization.

Florida panther. (Jessie Cohen/NZP Graphics)

Niles Lehman, a biologist at UCLA who participated in the canine DNA investigations, says that although a lot of coyote mtDNA has found its way into wolf populations, it may have come from only a few wolf–coyote encounters.

Scientists who study canid behavior say that mating between the two species is an unusual outcome when a wolf meets a coyote. In abundant forests with numerous wolves, the packs kill any lone coyotes they come across. Coyotes avoid confrontations with these packs by remaining on the outskirts of their territory. As the wolf's range shrinks and the coyote expands north and east, their relations may be changing.

Lehman notes that wolves with coyote mtDNA in Minnesota look like wolves, while the "coywolves" of Ontario and Quebec, where coyotes have only recently come on the scene, "look different from your run-of-the-mill timber wolf." The differences in appearance, Lehman says, parallel the advance of coyotes into new regions. "If you look 50 years into the future, the frequency of wolves with coyote mitochondrial DNA will probably drop as wolves become accustomed to coyotes," he says.

Nevertheless, the Montana, Idaho, and Wyoming Farm Bureaus petitioned in 1990 to strike gray wolves from the endangered

Some timber wolves have coyote genetic material, evidence of occasional hybridization between the two species. (Jessie Cohen/NZP Graphics)

The Molecular Magnifying Glass

At the National Zoo, it started with the giant panda mystery. For more than a century, scientists had debated the evolutionary ancestry of the Zoo's most famous residents. Some placed giant pandas in the bear family. Others placed them with raccoons. Still others contended that giant pandas belonged in a family all their own. The traditional tools of taxonomy—analysis of the clues found in teeth and bones and behavior—stubbornly refused to yield a definitive answer and opinions shifted and changed, seemingly with each new scientist who tackled the problem.

Clearly a new approach was needed, so Zoo scientists turned to a different sort of detective. The high-tech Sherlock Holmes they found was Stephen O'Brien of the National Cancer Institute, a geneticist studying human cancer, and a friend and colleague of Zoo veterinarian Mitch Bush. Using techniques routine in human genetics research, but at the time seldom applied to animals, O'Brien quickly determined that giant pandas were indeed bears, but ones that had separated from the "main" bear line very early in the evolution of this group.

The solution of the giant panda mystery in the mid-1980s heralded a new age in zoology, in which cutting-edge molecular biology technologies, such as mitochondrial DNA analysis and DNA fingerprinting, began to be used routinely to solve puzzles not only about evolutionary relationships and issues in conservation biology, but also to study such phenomena as whale migration and the social behavior of lions.

Humpback whales migrate some 6,000 miles each year between cold waters around Iceland, Greenland, and North America and warmer tropical seas around Hawaii and the Dominican Republic. Based on behavioral observations, scientists suspected that the whales live and migrate in discrete populations, each with its own winter and summer grounds, much like one wealthy family might winter in Miami and summer in Martha's Vineyard, and another "migrate" between Washington and Kennebunkport. But scientists had no straightforward way to test this hypothesis until Scott Baker, a Smithsonian Postdoctoral Fellow working in O'Brien's lab, compared the mitochondrial DNA of whales on several different winter and summer grounds. His analysis confirmed what behavioral observations had suggested: The whales do live and migrate in distinct populations.

But what precisely is mitochondrial DNA (mtDNA for short) analysis about? What, for that matter, is mtDNA?

In the nucleus of every living cell are chromosomes—little packages of deoxyribonucleic acid (DNA), the chemical that carries our genetic heritage. Each cell also includes mitochondria—"factories" that manufacture energy for the cell's daily functions. These factories have their own packages of DNA—mtDNA—that are quite separate from nuclear DNA. A key feature of mtDNA is that we (and other animals) inherit it only from our mothers, while half of nuclear DNA comes from our mothers and half from our fathers. Mothers pass down mtDNA from generation to generation only through their daughters who have daughters.

This maternal inheritance pattern is one reason that mtDNA is an excellent tool for the study of populations. To understand why, think about the traditional perpetuation of surnames in Western culture: Only men pass on their last names, and only their sons who have sons perpetuate the names. As a result, if Smiths and Browns never intermarry, the Smith family tree will never include a Brown, and vice versa, although each will contain other assorted surnames. Similarly, if two wildlife populations are not interbreeding, their mtDNA will be quite different, maintaining different "surnames" in each population.

To do the analysis, scientists need samples of skin, blood, or other tissue. Baker, for example, used a retrievable hollow dart to nick small skin samples from unsuspecting whales. Next, each sample, usually frozen at the time of collection and later thawed in the lab, is cultured to produce an inexhaustible supply of cells, just as horticulturalists may perpetuate some plants.

With plenty of cells to work with, scientists extract the DNA from the cells, then perform a series of biochemical and physical manipulations that ultimately make fragments of mtDNA visible as patterns of black bands. MtDNA from different matrilines produces different patterns, so by comparing the patterns, scientists can tell whether the mtDNA is from the same or different matrilines.

DNA fingerprinting goes a step further—this technique identifies individuals. The methods of DNA fingerprinting are similar to mtDNA analysis except that nuclear DNA, specifically, parts of DNA called variable number tandem repeats (VNTRs), is visualized and compared. VNTRs are really "junk" DNA because, unlike other sequences that contain instructions for growth, development, and other functions, VNTRs seem to carry no information. They are, however, extraordinarily variable and rarely the same except between identical twins, so VNTRs uniquely identify an individual—just like a fingerprint.

Soon after the DNA fingerprinting technique was developed in the mid-1980s, forensic scientists began using it to resolve paternity questions and to identify rapists and other criminal offenders from fragments of hair or other tissue left at the scene of the crime. Just as quickly, O'Brien and others began to use the technique to identify individual animals in the wild, adding to studies of social behavior a way to determine how animals in groups are related to each other. For example, working with lion expert Craig Packer, O'Brien and his student Dennis Gilbert learned that all of the cubs in a lion pride were fathered by a single male, even though multiple males lived in the pride. He also confirmed that the adult males were brothers.

Sherlock Holmes often reached for a magnifying glass to examine bloodstains to solve a mystery. Modern-day zoologist-detectives do the same, using the techniques of molecular biology to reveal the genetic secrets contained in a spot of blood or a sliver of skin.

—Sriyanie Miththapala

species list because of their mixed coyote blood. The Interior Department ruled in favor of continued protection for wolves, but scientists may soon have to worry about saving the species from genetic dilution if crossbreeding continues.

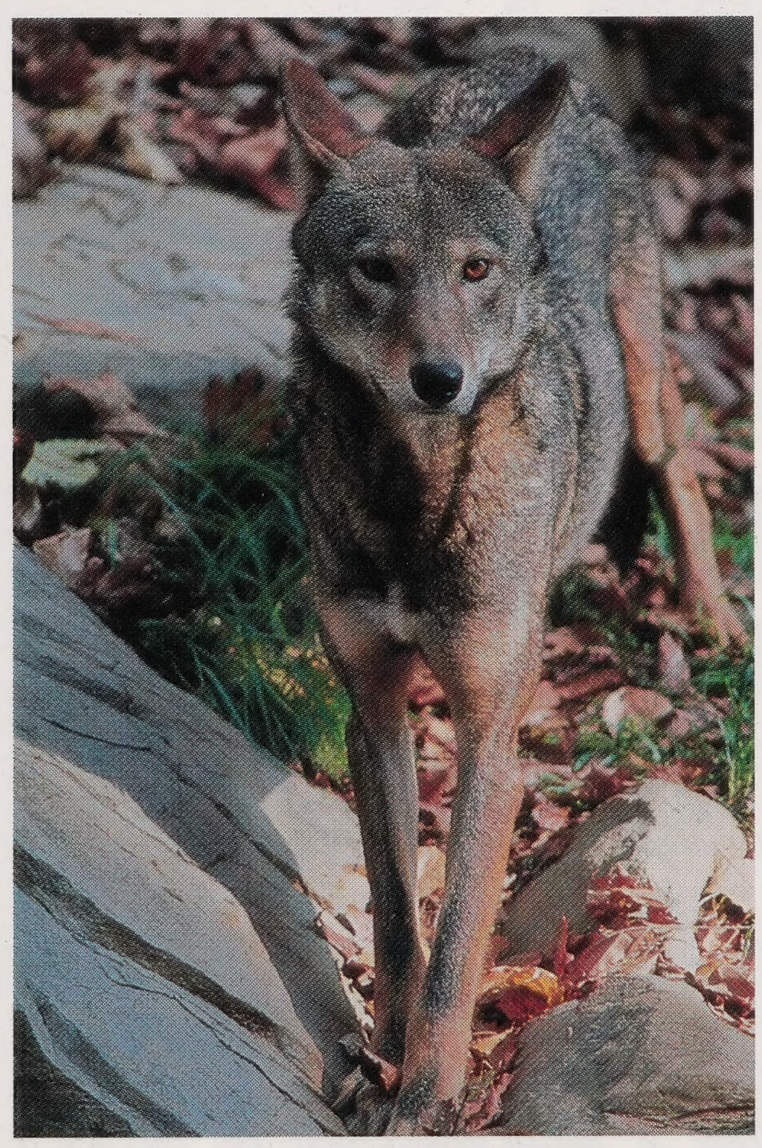
Lehman argues that his group's findings indicate that wolves need more, not less protection. "Hybridization happens when one species' habitat is disturbed, and it just adds one more threat to the list for wolves," he said. He points out that in relatively undisturbed habitat in Alaska, wolves live in the same areas as coyotes without hybridizing.

Coyotes have greatly expanded their range in the past century. (Jessie Cohen)

Queuing Up for Protection

The discovery of the Florida panther, red wolf, and gray wolf hybrids forced government agencies to rethink their previous hybrid policies. The U.S. Fish & Wildlife Service moved quickly when it saw that three top predators were about to have their purebred pedigrees removed, according to Ronald Nowak of the USFWS's Office of Scientific Authority. In light of new hybrid evidence, said Nowak, the USFWS will treat hybridization on a case-by-case basis.

This news comes as a relief to scientists, who now know that hybridization happens more often than people previously thought. Sometimes humans cause the disruption that leads to hybridization, but often animals hybridize for natural reasons: Their range changes and overlaps with another subspecies, for instance.



The red wolf is a timber wolf–coyote hybrid. (Jessie Cohen/NZP Graphics)

The natural hybrid zones of plants and animals pose little threat to the individual species involved as long as the lion's share of each species remains unchanged, according to O'Brien. If the two species mix all their genes together, then they become a new species, and the first two were not "good" species in the first place.

With 597 animals and plants on the federal endangered species list and 3,700 more waiting for protection, the question of which species are "good" weighs heavily on the minds of scientists and government officials, who spend their sparsely allotted money carefully. The problem gets more complicated when the level below species—subspecies—is added to the equation: Should some subspecies be saved while others die out?

The attention and funding devoted to saving the Florida panther shows that not all subspecies are created equal. In most cases, however, O'Brien favors saving species before subspecies because species represent a bigger investment in evolutionary time.

He also points out that classifying subspecies can be extremely difficult. "In the past, subspecies were named where people saw them. For instance, mountain lions were named state by state in Mississippi, Alabama, and other places," he says.

Because of this casual classification, scientists don't know what the real differences are between many subspecies. According to University of Georgia professor John Avise, a subspecies must have traits that distinguish it from the rest of the animals—either obvious traits, like marking, coloration, or size differences, or hidden traits within their genes. If scientists see a lot of differences between two subspecies, then they probably separated long ago. The more differences between subspecies, the more important it becomes to save their unique characteristics if one or both become endangered.

Now that molecular genetics has arrived on the scene, scientists can better identify and quantify differences between subspecies and species. They can study differences in mitochondrial DNA to determine the relatedness of all sorts of animals, including humans.

Ironically, a retrospective analysis of the mtDNA of dusky seaside sparrows revealed that this subspecies was virtually identical to other seaside sparrows living on the Atlantic coast, but quite different from Scott's seaside sparrow, the Gulf coast subspecies that biologists tried to cross with the dusky.

The genetic techniques that led to these new relationship revelations have popped up recently, and many scientists think that more surprises are in store. "I think that we will probably find more and more hybrids, particularly in closely related groups," says Gittleman. "These molecular techniques have described things about genetic relationships that we hadn't even thought about 10 years ago." ✤

Former ZooGoer *intern Melissa Blouin is a reporter and editor with the* Northwest Arkansas Times.

The Bad News...

The Brazilian Amazon included only two national parks in 1979. Moving quickly to address the problem, the government of Brazil has added eight more national parks, eight biological reserves, and 15 ecological stations and reserves since that time.

However, these areas, which cover sections of rainforest roughly equal in size to the state of Washington, are for the most part protected in name only, according to a recent World Wildlife Fund report. The report notes that Brazil's natural resource agency, IBAMA, can afford to employ only one guard for every 2,300 square miles of "protected" forest. IBAMA also lacks funds to compensate landowners affected by creation of the parks and reserves, as required by law.

Protecting Brazil's amazing diversity of plant and animal life requires considerable assistance from the world's wealthy nations. To expect Brazil—which is burdened with the largest external debt in the developing world—to carry the load alone is simply unrealistic.

From Focus, *May/June 1992.*

...The Good News

Recent growth of the conservation movement in Brazil has focused attention on a variety of native species such as the endangered maned wolf. A newly established Maned Wolf Management Group has succeeded in increasing birthrates and 30-day survival rates in Brazilian zoo populations. Until recently, however, the unavailability of a safe canine distemper vaccine in Brazil meant that only 14 percent of zoo-born pups reached the age of six months. When members of the American Association of Zoological Parks and Aquariums' (AAZPA) Maned Wolf Species Survival Plan became aware of the problem last September, the Denver Zoo immediately offered the Zoological Society of Brazil a generous supply of Fromm-D distemper vaccine. The manufacturer of the Fromm-D vaccine, Solvay Animal Health, provided an additional 120 free doses to Brazilian zoos.

From AAZPA Communique, *April 1992.*

The Area Scene

Young raccoons, born in April and early May, emerge from their dens and travel with their mothers in search of food toward the end of July and early August.

In preparation for winter, raccoons need to fatten up at this time of year, and generally increase their body weight by about one-third between September and December. Raccoons in the Washington area take advantage of various fleshy fruits that ripen during late summer and early autumn. The wild black cherries of mid-August and early September give way to a variety of wild and domestic grapes by late September. October brings persimmons, a raccoon favorite, and families will frequently camp out under a tree until they have exhausted its fruit.

Songbird migration reaches its peak in September and early October, with many insect-eating species passing through on their way south. Backyard and woodlot visitors include yellow warblers, scarlet tanagers, Baltimore orioles, and several species of flycatchers and vireos.

(Christy Bowe)

The fall migration isn't as colorful as the spring migration, with young birds in immature plumage and most adults already in their more subdued winter plumage. Also absent is the joyous birdsong of spring; come fall, the breeding urge is gone and the singing is gone with it.

What's In a Name?

Koala "bears," of course, are not bears at all but marsupial mammals. The name "koala" comes from the Aborigine word meaning "no water," and suits this animal well because it does not normally drink water. All the moisture in the koala's diet comes from the 12 species of eucalyptus leaves it eats. Australians also refer to koalas as bangaroos, kollewongs, and naragoons.

"Releaf" for Cities

According to a National Urban Forest Council report, computer simulations project that 100 million mature trees in U.S. cities—that's 1.5 trees per single-family home—could reduce energy use by 30 billion kilowatt hours annually. This represents about $2 billion per year in energy cost savings, in addition to the money saved from reduced investment in power plants. Reduced energy consumption could also mean cutting CO_2 emissions by as much as nine million tons per year.

From Urban Forests, *April/May 1992.*

Urban Animal Safari

The Washington metropolitan area provides ideal habitat for a variety of wild animal artistic creations. These lively, if inanimate, creatures range all over the region, from our most famous public places to the most secluded private lairs. Pictured above is one of these fantastic animals—do you know where to spot it? (Look for the answer in our November/December issue.)

Answer to the May/June Urban Animal Safari: King Bee Liquors, 1406 H Street, N.E., Washington, D.C.

Coca-Cola

Trade-mark ®

CLASSIC

Can't Beat The Real Thing.

Friends of the National Zoo
National Zoological Park
Washington, D.C. 20008

Address Correction Requested

Nonprofit Organization
U.S. Postage
PAID
Washington, D.C.
Permit No. 6282